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INVENTOR-INFORMATION:

NAME	COUNTRY
DONNER, RALF	DE
DEGENKOLB, DIETMAR	DE
SCHINGNITZ, MANFRED	DE

ASSIGNEE-INFORMATION:

NAME	COUNTRY
KRC UMWELTTECHNIK GMBH	DE

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(56) Documents Cited by ISA

EP 0254830 A FR 002569827 A US 4343626 A

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(71) Applicant(s)

Noell-KRC Energie-und Umwelttechnik GmbH
(Incorporated in the Federal Republic of Germany)
Industriestrasse 70, D-04435 Schkeuditz,
Federal Republic of Germany

(74) Agent and/or Address for Service

Potts, Kerr & Co
15 Hamilton Square, BIRKENHEAD, Merseyside,
CH41 6BR, United Kingdom

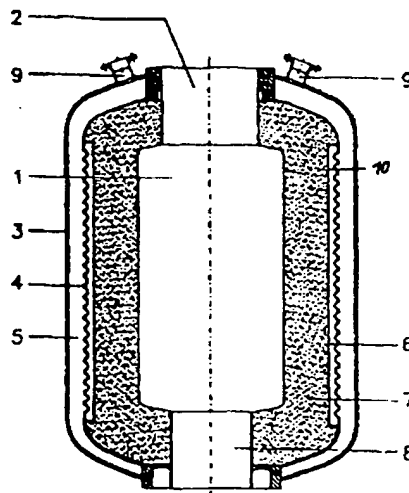
(72) Inventor(s)

Ralf Donner
Dietmar Degenkolb
Manfred Schingnitz

(54) Abstract Title

Device for gasifying combustible materials, residues and waste materials containing carbon

(57) The invention relates to a device for gasifying combustible materials, residues and waste materials containing carbon and ash, using an oxidation agent containing oxygen at temperatures above the melting point of the inorganic constituents, in a reaction chamber configured as an entrained flow reactor and at pressures between ambient pressure and 80 bar but preferably between ambient pressure and 30 bar. The outline of the reaction chamber is delimited by a cooled reactor wall which consists of the following elements, moving from the outside towards the inside: a pressure envelope (3), a cooling wall (4), a water-cooled gap (5) between the pressure envelope (3) and cooling wall (4), a ceramic protection (6) for the cooling wall (4), and a layer of slag (10). The pressure and temperature in the cooling gap (5) between the pressure envelope (3) and the cooling wall (4) are controlled such that it can be operated below and above the boiling point of the cooling water, the pressure in the cooling gap (5) being higher than the pressure in the gasification chamber (1).



GB 2 344 350 A

Figure 1

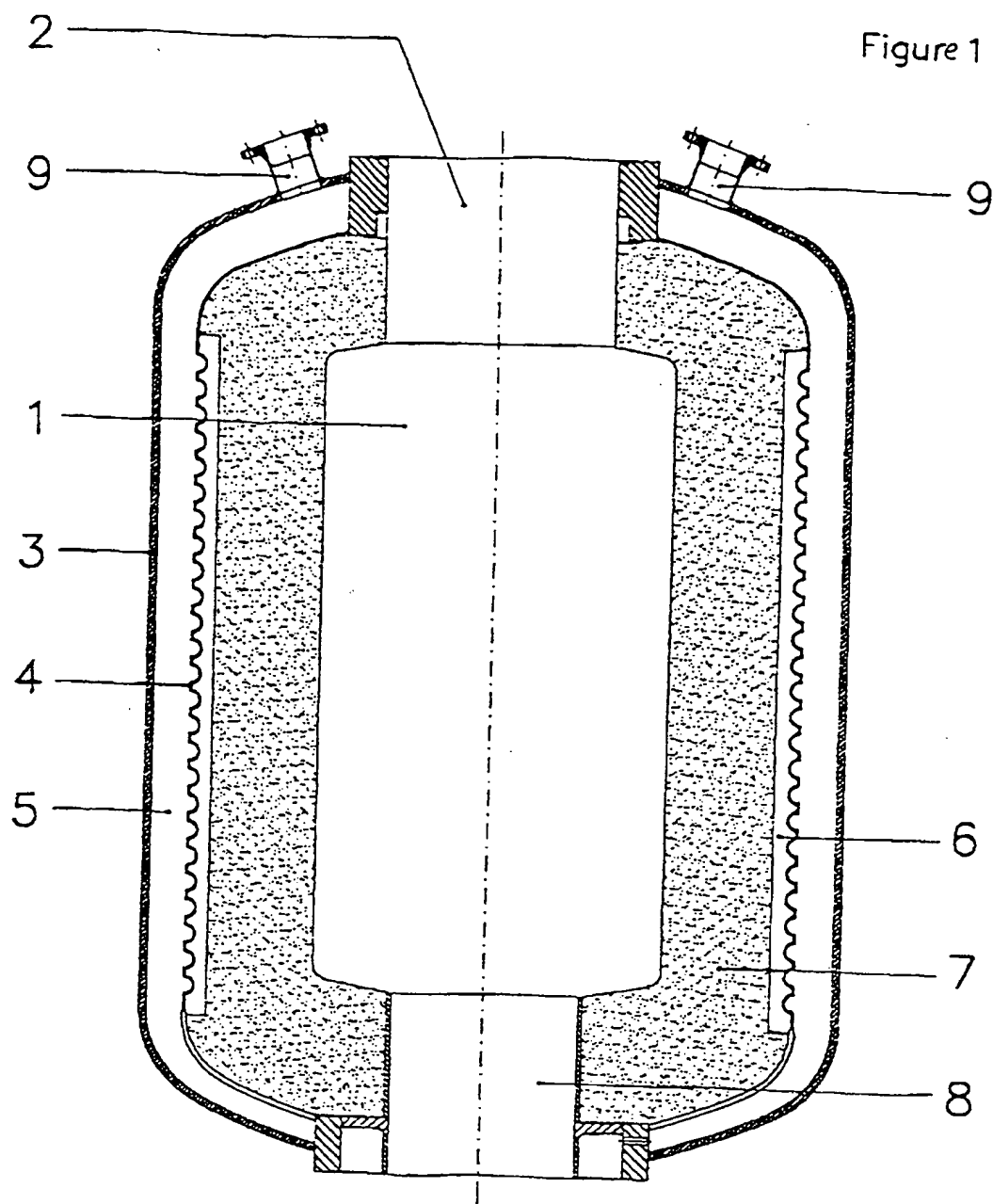
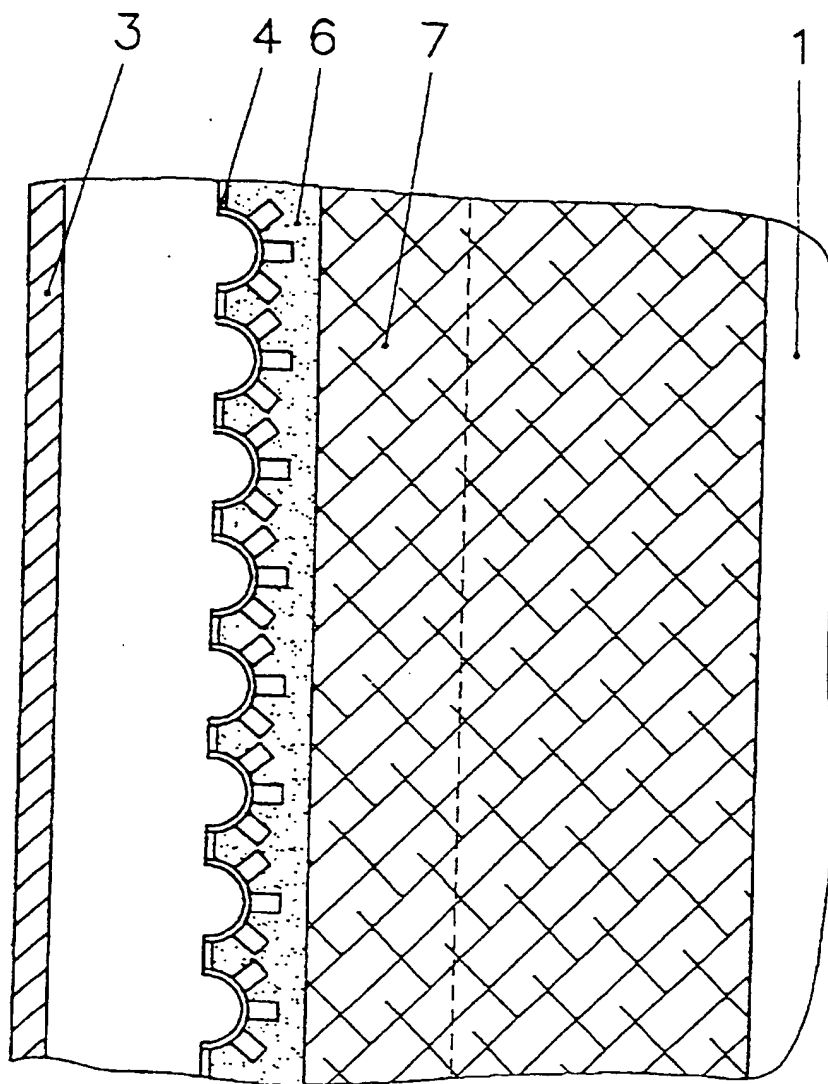


Figure 2



Apparatus for gasifying carbon-containing fuels, residual and waste substances

Description

The invention relates to an apparatus for gasifying carbon-containing fuels, residual and waste substances in accordance with the first and second claims.

What is to be understood by the term fuels and waste substances are those substances with or without an ash content, such as lignites or bituminous coals, as well as their cokes and water/coal suspensions, but also oils, tars and sludges, as well as residues or waste materials from chemical and wood-pulping processes, such as, by way of example, black liquor from the kraft process, as well as solid and liquid fractions from refuse and recycling businesses such as waste oils, PCB-containing oils, fragments of plastics material and household refuse or their processed products, lightweight shredders from processing scrap from the car, cable and electronic industries, as well as contaminated aqueous solutions and gases. The invention can be used not only for flow stream gasifiers but also for other gasification systems such as fixed-bed or fluidised-bed gasifiers or a combination thereof.

In gas generation technology, the autothermic flow stream gasification of solid, liquid and gaseous fuels has been known for many years. In such case, the ratio of fuel to oxygen-containing gasifying agents is so selected that, for reasons concerning the quality of synthesis gas, higher carbon compounds are completely broken-down to form synthesis gas components such as CO and H₂, and the inorganic constituent ingredients are discharged in molten form (J. Carl, P. Fritz, NOELL-KONVERSIONSVERFAHREN, EF-Verlag für Energie- und Umwelttechnik GmbH, Berlin, 1996, P.33 and P.73).

In such case, according to various systems introduced into the technology, gasification gas and the molten inorganic constituent, e.g. slag, can be separately or jointly discharged from the reaction chamber of the gasification apparatus (DE 19718131.7).

Systems, which are also provided with a refractory lining or are cooled, are introduced for internally defining the reaction chamber of the gasification system (DE 4446803 A 1).

Gasification systems provided with a refractory lining have the advantage of smaller heat losses and, in consequence, provide an energetically effective conversion of the fuels supplied. However, they can only be used for ash-free fuels, since the liquid slag, flowing away on the inner surface of the reaction chamber during the flow stream gasification process, dissolves the refractory lining and, in consequence, only permits very limited travel times before a cost-intensive relining is required.

In order to overcome this disadvantage with ash-containing fuels, therefore, cooled systems were created according to the principle of a diaphragm wall. Because of the cooling, a solid layer of slag is initially formed on the surface associated with the reaction chamber, and the thickness of said layer increases until the slag, piled-up further from the gasification chamber, passes this wall in liquid form and, for example, flows from the reaction chamber jointly with the gasification gas. Such systems are very stable and ensure long travel times. A substantial disadvantage of these systems resides in the fact that up to approx. 5 % of the energy introduced is transferred to the cooled screen.

Various fuels and waste substances, such as heavy metal-containing or lightweight ash-containing oils, tars or sludges of tar and oil solids, for example, contain too little ash in order to form a sufficiently protective layer of slag when the reactor walls are cooled, and such leads to additional losses of energy, though the ash content is too high to prevent the refractory layer from

melting or dissolving in the case of refractory-lined reactors and to achieve sufficiently long travel times before relining is required.

An additional disadvantage resides in the complex structure of the reactor wall, and such may lead to considerable problems in manufacture and operation. Thus, for example, the reactor wall of the flow stream gasifier illustrated in J. Carl, P. Fritz: NOELL-KONVERSIONSVERFAHREN, EF-Verlag für Energie- und Umwelttechnik GmbH, Berlin, 1996, P.33 and P.73, comprises a pressureless water jacket, the pressure-resistant jacket which is protected against corrosion on the inside by a mixture of tar and epoxy resin and is lined with lightweight refractory concrete, as well as the cooling screen which, like a diaphragm wall commonly used in boiler construction, comprises gastightly-welded, water-traversed cooling tubes which are studded and covered with a thin layer of SiC. A cooling screen gap exists between the cooling screen and the pressure-resistant jacket, which is covered with refractory concrete, and said gap has to be rinsed with a dry, oxygen-free gas in order to prevent back-flows and the formation of condensate.

Based on this prior art, an object of the invention is to provide an apparatus which, whilst having a simple and reliable mode of operation, takes account of the most varied ash contents of fuels and waste substances.

This object is achieved by the features of claims 1 and 2.

An additional embodiment of the apparatus according to the invention is contained in the subsequent claims.

The apparatus according to the invention is suitable for the gasification of fuels, waste and residual substances having the most varied ash contents, as well as for the combined gasification of hydrocarbon-containing gases, liquids and solids.

According to the invention, provision is made for the configuration of the reaction chamber for the gasification process to be defined by a refractory lining or by a layer of solidified slag. When there is a lining of refractory material, such material is protected by intensive cooling, or liquid slag is solidified, so that a thermally insulating layer is formed. Cooling is achieved through a water-filled cooling gap, whereby operational conditions can be set above or below the boiling point.

The invention is to be explained more fully with reference to two embodiments illustrated in Figures 1 and 2.

In embodiment 1, Figure 1 illustrates the gasification reactor. The reaction of the fuels, residual and waste substances with the oxygen-containing oxidising agent to form a crude gas rich in H_2 and CO is accomplished in the reaction chamber 1. The gasifying agents are supplied via special burners which are mounted on the burner flange 2. The crude gasification gas, possibly together with liquid slag, leaves the reaction chamber 1 via the opening 8, which is provided with a special apparatus, and it passes to subsequently added cooling, washing and processing systems. The gasification reactor is covered by the pressure-resistant jacket 3, which absorbs the differential pressure between the reaction chamber 1 and the outside atmosphere. For the thermal protection of said reactor, a cooling gap 5 is provided which, when filled with water, can be operated above or below the boiling point, which is dependent on the overall pressure. In order to prevent gasification gas from entering the cooling gap 5 in the event of damage, the pressure in said gap is always kept higher than the pressure in the reaction chamber 1. The cooling gap 5 is inwardly defined by a cooling wall 4. The hot water produced in the cooling gap 5, or the vapour, is discharged via the pipe connections 9. The cooling wall 4 may be provided with a thin, ceramic protective layer 6, which is firmly bonded to the surface thereof. The temperatures in the cooling gap 5 may be between 50 and 350° C, depending on the process pressure. For the gasification of starting substances which are ash-free or extremely low in ash, it is advantageous to face the cooling wall 4 with refractory, heat-insulating brickwork as the

refractory lining 7 in order to limit the entry of heat into the cooling gap 5. When ash-containing fuels, residual and waste substances are used, the refractory brickwork 7 may be omitted. The liquid slag, forming in the reaction chamber 1, is cooled on the cold surface of the cooling wall 4 and its coating 6; it solidifies and forms, in this manner, a refractory lining as slag layer 10, which increases towards the reaction chamber 1 until the temperature has reached the melting point of the slag. The slag, which has then piled-up further, flows away as slag film and is discharged with the hot crude gas via the opening 8.

Figure 2 illustrates the embodiment of the cooling wall 4 by way of example. In such case, it comprises a wall of gastightly welded half-tubes, which are studded and tamped with a thin layer of silicon carbide. The ceramic lining is situated on the side facing the reaction chamber 1 as slag layer 10 which, as illustrated in Example 1, is artificially* applied or is even formed by its own molten ash. Other configurations for the cooling wall, such as one formed from corrugated sheet metal or one with a trapezoidal, triangular or rectangular configuration, for example, are possible depending on the manufacturing techniques. The application and securement of the ceramic protective layer 6 may be effected by mechanical supporting means, such as in Example 2, but they may also be effected by chemical bonding or thermal application, such as by flame-spraying.

Furthermore, it is easily understandable that the embodiment, illustrated in Example 2, for the wall defining the reaction chamber 1 and having the component parts 3, 4, 5, 6 and 7, may be used not only for greatly thermally charged flow stream gasification reactors, but also for other gasification systems, such as, for example, fixed-bed or fluidised-bed gasifiers or combinations thereof.

*Translator's note: Perhaps "künstlich" is a clerical error for "künstlerisch" (artistically).

List of reference numerals used

- 1 Reaction chamber
- 2 Flange for burner insert
- 3 Pressure-resistant jacket
- 4 Cooling wall
- 5 Cooling gap
- 6 Ceramic protective layer for the cooling wall
- 7 Refractory lining of the reactor
- 8 Opening for the emergent gas and slag
- 9 Pipe connections for a vapour or hot-water connection
- 10 Slag layer

Claims

1. Apparatus for gasifying carbon- and ash-containing fuels, residual and waste substances with an oxygen-containing oxidising agent at temperatures above the melting point of the inorganic constituents in a reaction chamber, configured as a flow stream reactor, at pressures between ambient pressure and 80 bar, preferably between ambient pressure and 30 bar, wherein the configuration of the reaction chamber is defined inwardly from externally by a cooled reactor wall of the following structure:

- pressure-resistant jacket (3)
- cooling wall (4)
- water-cooled cooling gap (5) between pressure-resistant jacket (3) and cooling wall (4)
- ceramic protective layer (6) for the cooling wall (4)
- slag layer (10),

and the cooling gap (5) between pressure-resistant jacket (3) and cooling wall (4) is so pressure- and temperature-controlled that said gap can be operated below or above the boiling point of the cooling water, the pressure in the cooling gap being higher than the pressure in the gasification chamber.

2. Apparatus for gasifying carbon-containing, ash-free fuels, residual and waste substances with an oxygen-containing oxidising agent at temperatures above 850° C in a reaction chamber, configured as a flow stream reactor, at pressures between ambient pressure and 80 bar, preferably between ambient pressure and 30 bar, wherein the configuration of the reaction chamber is defined inwardly from externally by a cooled reactor wall of the following structure:

- pressure-resistant jacket (3)
- cooling wall (4)

- water-cooled gap (5) between pressure-resistant jacket (3) and cooling wall (4)
- ceramic protective layer (6) for the cooling wall (4)
- refractory lining (7),

and the cooling gap (5) between pressure-resistant jacket (3) and cooling wall (4), when filled with compressed water, can be operated below or above the boiling point of the cooling water, the pressure in the cooling gap (5) being higher than the pressure in the gasification chamber (1).

3. Apparatus according to claims 1 and 2, wherein the cooling wall (4) comprises gastightly welded half-tubes, which are studded and covered with a thin layer of ceramic material of high thermal conductivity.

4. Apparatus according to claims 1 and 2, wherein the thin layer of ceramic material is applied to the cooling wall (4) by flame-spraying.

5. Apparatus according to claims 1 to 4, wherein the cooling wall (4) may have geometrical configurations, such as a trapezium, triangle or rectangle, or an undulatory or smooth configuration.

INTERNATIONAL SEARCH REPORT

I. International Application No

PCT/DE 98/01995

CLASSIFICATION OF SUBJECT MATTER

C 6 C10J3/48

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 C10J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 343 626 A (PEISE) 10 August 1982 see column 6, line 16-41 ---	1-3
A	EP 0 254 830 A (KRUPP KOPERS) 3 February 1988 see page 3, column 4; claims 1-3 ---	1
A	FR 2 569 827 A (BRENNSTOFFINST. FREIBERG) 7 March 1986 see page 5, line 24 - page 8, line 10 -----	1-3

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

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Name and mailing address of the ISA

European Patent Office, P. B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Wendling, J-P

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/DE 98/01995

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